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SYMPOSIUM ON THIN FERROMAGNETIC FILMS

-USSR-

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(Following is the translation of an article by V. Ye. Kuznetsov in Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, No 11, Novosibirsk, November 1960, pages 144-145.)

In accordance with the resolution of the Scientific Council of the Section of Physico-Mathematical Sciences of the Academy of Sciences USSR on the problem "Physics of Magnetic Phenomena," a symposium on thin ferromagnetic films, organized by the Institute of Physics of the Siberian Section of the Academy of Science, USSR, was held in Krasnoyarsk 4-9 July 1960.

Participating in the symposium were scientists and engineers from Moscow, Sverdlovsk, Kiev, Krasnoyarsk, Khar'kov, Novosibirsk, Yerevan, Perm', Penza, Makhach-Kala and other cities, 75 persons in all, representing 28 research and educational institutions and enterprises of the country.

The symposium discussed 30 papers dealing with the methods of obtaining and investigating thin ferromagnetic films, their crystal and magnetic structure, remagnetization processes and magnetic properties.

The original reports were preceded by two survey papers. The first, read by Prof R. V. Telesnin (Moscow State University), contained data on the electric, magnetic and optic properties of mangetic films, and on the methods of obtaining and investigating them. It pointed out the difficulties of measuring the thicknesses of films, the physical processes occurring in the film when covered with dust, the peculiarities of the change in the electric resistance of films depending upon the temperature of the substratum, the rate of coverage with dust, subsequent annealing of the film, etc.

The second survey paper, presented by Prof K. M. Polivanov (Moscow Power-Engineering Institute), was devoted to the peculiarities of the employment of thin films in mathematical machines and fast-working automatic devices. The paper reported that the time of re-magnetization of films by two orders is less than with the ferrite rings used in mod

modern data-processing (informatsionno-logicheskiye) machines. According to literature data, re-magnetization of discs 2.5 mm in diameter takes place in 20 nana-seconds Stress was laid on the advantages of using ferromagnetic films in computing-and-deciding devices (small diminsions, great speeds of re-magnetization, stability) and in parametric systems at high frequencies.

A theoretical paper by A. M. Rodichev (Institute of Physics of the Siberian Section of the Academy of Sciences, USSR, Krasnoyarsk) examined re-magnetization through homogeneous rotation of thin magnetic layers possessing uniaxial anisotropy in the plane of the film. He has obtained the dependence of the time of re-magnetization of the film upon the magniture of the external field, the field of anisotropy and the initial state of the film (angle between the initial direction of the magnetic moment and the direction of the re-magnetizing field). The results were compared with the experimental data available in the literature.

Great interest was aroused by the results of the investigation of the hysteresis loops of permalloy films, reported by V. V. Kobelev (Institute of Precision Mechanics and Computing Technology of the Academy of Sciences, USSR, Moscow). It was established that the form of the hysteresis loop of the film depends upon the method of applying the re-magnetizing field and the arrangment of the computing winding. By removing the hysteresis loops of the film, in rotating it together with the winding relatively to the direction of the action of the magnetic field, it is possible to judge how pronounced the anisotopy of the sample (of film) is. Placing two perpendicular coils on the sample makes it possible to observe on the oscillograph screen the hodogrpah of the magnetic moment of the film as well as the usual hysteresis loops. When the field acts at an angle to the axis of easy magnetization, one at first observes pure magnetization rotations, but after the magnetization has been turned to a certain critical angle, processes of intensive domain formation commence.

A paper by A. S. Mil'ner and L. I. Tatarinova (Khar'kov State University) reported on the results of investigations into the influence of the granularity of fine films on the Curie point. The authors explain the presence of a second low-temperature Curie point and the anomalous course of the ohmic resistance in dependence upon the temperature (in nickel specimens) by the fact that the film consists of very fine grans. The Curie temperature depends not only upon the thickness of the film, but also upon the dimensions of its grains.

Great interest was aroused by the reports on investigations of the domain structure of thin ferromagnetic layers.

L. V. Kirenskiy (Institute of Physics of the Siberian Section of the Academy of Sciences, USSR), I. F. Degtyarev and S. V. Kan (Krasnoyarsk Pedagogic Institute) made a study of the dynamics of the magnetic structure of films with the aid of the Kerr magneto-optic effect and demonstrated the change in the structure of permalloy-molybdenum films in dependence upon the temperature and external magnetic field.

A. A. Korsunskiy and V. V. Kobelev (Institute of Precision Mechanics and Computing Technology of the Academy of Sciences, USSR, Moscow), reported data on the domain structure of anisotopic permalloy films. In a homogeneous magnetic field directed at an angle to the axis of easy magnetization, the films are re-magnetized by displacing the boundaries. When the field is applied in a direction close to the difficult axis, pure rotations of the magnetization vector are observed. After removal of the applied field, the magnetization in some specimens remains directed along the difficult axis, while in others it returns to the easy axis with formation of small domains.

Original results from an investigation of the dynamics of the magnetic structure of thin films were contained in a motion picture and reports by L. V. Kirenskiy, V. A. Buravikhin and M. K. Savchenko (Institute of Physics of the Academy of Sciences, USSR). They graphically demonstrated the change in the domain structure with the growth of the thickness of the film to the dimensions of the usual massive specimens. They ascertained the dependence of the magnetic structure upon the magnitude and direction of the magnetic field.

A study by M. K. Savchenko and V. I Sinegubov (Institute of Physics of the Siberian Section of the Academy of Sciences, USSR), made the first direct experimental measurement of the boder layer between domains in films of permalloy. The width of the boundary was found to be 0.7 μ. Further development of these investigations may furnish valuable information relating to the magnetization of materials, their coercive force and other magnetic characteristics.

N. G. Nifontov (Dagestan State University) told about obtaining monocrystallic semiconductor films. He elucidated the methods of preparing the films, gave an example of applying successively oriented silver and copper films to a substratum of rock salt and described the method of obtaining monocrystallic germanium films on fluorite.

The method of obtaining ferromagnetic films by cathode pulverization was described in a paper by G. V. Spivak, I. G. Sirotenko and R. D. Ivanov (Moscow State University). By comparison with others, it possesses a number of advantages: It insures the pulverization of materials with any melting point and controls the thickness of the film, the uniformity

of powdering and the great purity of the films.

N. V. Kotel'nikov and V. I. Gachegov (Perm' State University) reported on the results of investigations of the magnetic properties of nickel sediments obtained by the chemical nickelization method. The ferromagnetic properties of the precipitated nickel differ sharply from the properties of pure nickel. An increase of the hypophosphite in the bath leads to a weakening of the magnetic properties of the sediments. A linear diminution was discovered in the degree of magnetization at the saturation point, in the residual magnetization and in the coercive force with the rise in the temperature.

A report by V. A. Yugov and G. P. D'yakov (All-Union Scientific-Research Institute of Physico-Technical and Radiotechnical Measurements, Moscow State University) was devoted to the use of thin films in measuring magnetostrictional and other deformations. They proposed a new type of tensometer (fiom), with which the magnetostriction of magnesium and nickel ferrites was measured.

A paper by T. N. Nikitina and R. V. Telesnik (Moscow State University) described an installation created by them to obtain the impulsive re-magnetization of thin ferromagnetic films.

A number of papers were devoted to the study of the Barkhausen effect in thin magnetic layers.

G. M. Rodichev, P. D. Kim and V. S. Prokopenko (Krasnoyarsk) attempted to determine the length of the Barkhausen jump in films and discovered that it is less than two microseconds.

A. M. Rodichev, M. K. Savchenko and N. M. Salanskiy (Institute of Physics of the Siberian Section of the Academy of Sciences, USSR) investigated the Barkhausen effect on permalloy films in dependence upon their thickness and upon the conditions producing anisotropy in films.

V. F. Ivlev and V. S. Prokopenko (Krasnoyarsk Pedagogic Institute) expressed the supposition that the Barkhausen effect in films is determined by the rise and further growth of embryos of re-magnetization. The data on the experiment were compared with the Ferd and Pat Model.

A part of the papers contained investigations of ferromagnetic resonance in ferromagnetic films, impulsive re-magnetization, anisotopy, rotational hysteresis, etc.

The symposium adopted a resolution noting the timeliness of its convocation, the necessity for the publication of works and the advisability of holding a conference on thin ferromagnetic films in 1961.

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